

# Caprella drepanochir

A skeleton shrimp, or caprellid amphipod

Phylum: Arthropoda, Crustacea  
Class: Malacostraca  
Order: Amphipoda, Caprellidea  
Family: Caprellidae

**Taxonomy:** The Caprellidae are a very distinctive family of amphipods. They were previously a separate amphipod suborder, but were recently found to be polyphyletic, arising at least twice from different gammarid amphipod lineages (Laubitz 1993; Takeychi 1993; Watling and Carlton 2007). Current research places them as highly modified members of the suborder Corophiidea (Myers and Lowry 2003; Watling and Carlton 2007), a taxon divided into two infraorders (Caprellida, Corophiida) each with different evolutionary feeding strategies and associated morphology (Myers and Lowry 2003).

## Description

**Size:** The illustrated specimens (from Coos Bay) include a 13 mm long male (Fig. 1) and an 8 mm long female (Fig. 2) (Measured from anterior (head) to posterior (abdomen), Laubitz 1970). Males collected in Japan were 13 mm (Arimoto et al. 1976; Utinomi 1943) while those from Alaska were 12.4 mm in length (Laubitz 1970).

**Color:** White, with brown chromatophores. The illustrated female is darker than the male specimen.

**General Morphology:** The body of amphipod crustaceans can be divided into three major regions. The **cephalon** (head) or cephalothorax includes antennules, antennae, mandibles, maxillae and maxillipeds (collectively the **mouthparts**). Posterior to the cephalon is the **pereon** (thorax) with seven pairs of pereopods attached to pereonites followed by the **pleon** (abdomen) with six pairs of pleopods. The first three sets of pleopods are generally used for swimming, while the last three are simpler and surround the telson at the animal posterior. Caprellid amphipods differ from the rest of amphipoda in that the abdomen is greatly reduced, especially the last three abdominal segments (urosome) and associated appendages (uropods). Their body is also elongated

rather than laterally compressed (compare to gammarid amphipods, e.g. *Eogammarus confervicolus*) (Kozloff 1993; Watling and Carlton 2007).

**Cephalon:** Round cephalon with no dorsal spines or tubercles (Fig. 1) (Laubitz 1976), however body spination is a highly variable trait among individuals (Watling and Carlton 2007). Head partially fused with the first pereonite (segment of pereon) and the first pair of gnathopods (Fig. 1). Pereonite one not more than twice as long as head in male (Laubitz 1970) and shorter in female (Laubitz 1970) (Fig. 2).

**Rostrum:** Cephalon without rostrum (Laubitz 1976).

**Eyes:** Small (Laubitz 1976) (Fig. 1).

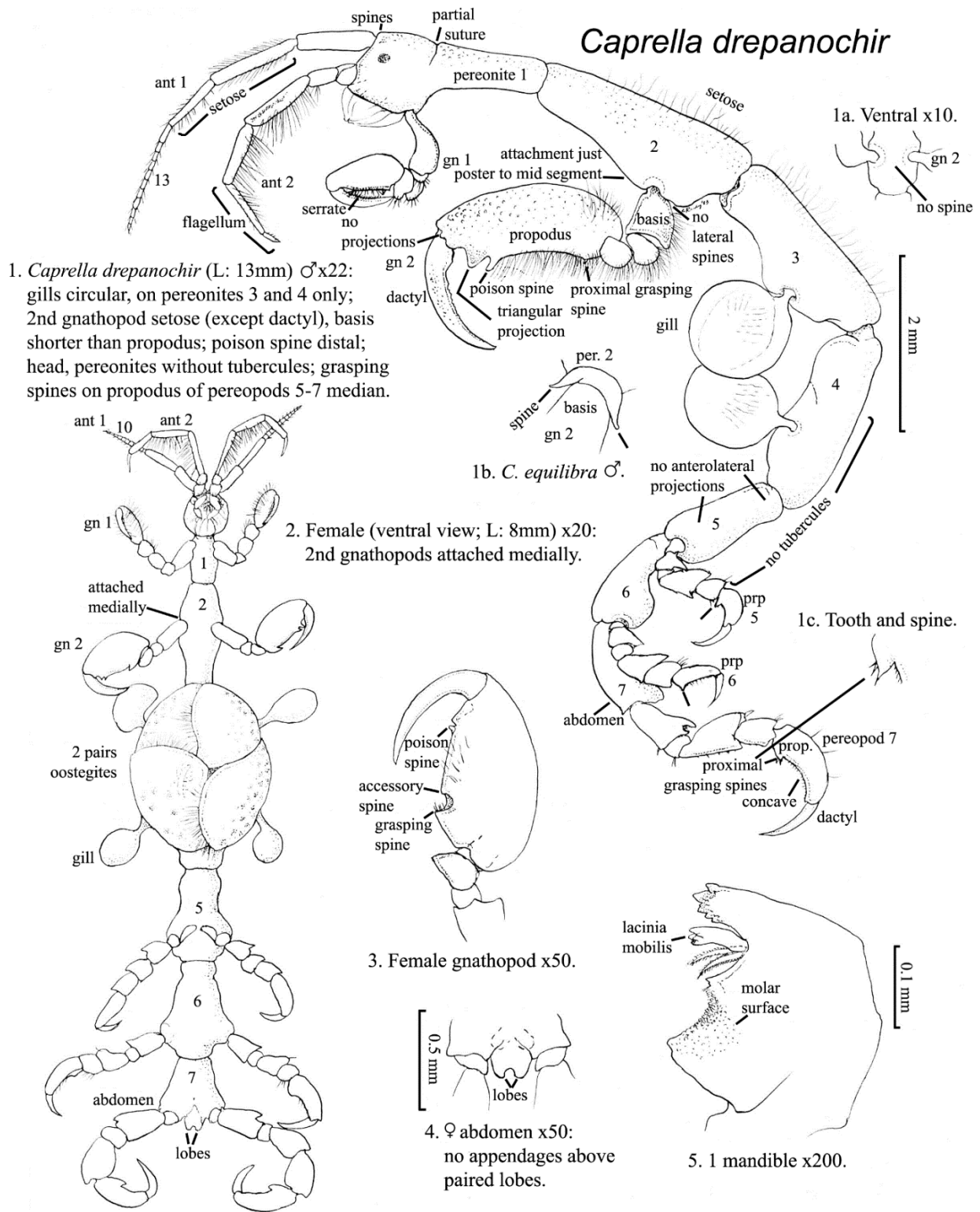
**Antenna 1:** Less than half total body length (Laubitz 1970). In males, the first antenna is approximately equal to the cephalon combined with pereonite two (Laubitz 1970) (Fig. 1). Articles 2–3 of peduncle are setose while the flagellum is shorter than peduncular articles one and two, and bears 13 articles (Laubitz 1970) (Fig. 1). In the illustrated female, antenna one is a little longer than cephalon and pereonite one and the flagellum has 10 articles (Fig. 2).

**Antenna 2:** Antenna two in the illustrated specimens is longer than the peduncle of antenna one and has flagellum with short setae (Laubitz 1970) (Figs. 1, 2).

**Mouthparts:** Mandible with molar (McCain 1975) and without palp (McCain 1975). Left 'lacinia mobilis' with five teeth (Fig. 5) and right 'lacinia mobilis' denticulate but not five-toothed (McCain 1975) (not figured).

**Pereon:** Pereon with only six segments (not seven as in other amphipods) and no pereopods on pereonites three or four (Caprellidae, McCain 1975; Laubitz 1976). Pereonites cylindrical and longer than deep (Laubitz 1976). Pereonites in this species are without dorsal spines or tubercles, but are covered with fine hairs (Fig. 1). Male

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pereonite one is not more than twice the length of the head while female pereonite one is shorter than the head (Laubitz 1970) (Fig. 2). Gills on pereonites three and four only. Round in shape and fleshy (*Caprella*, Mayer 1890; Watling and Carlton 2007) (Figs. 1, 2). Gills in male individuals are more circular and females are broadly rounded (Watling and Carlton 2007). Oostegites (marsupium) present on pereonites 3–4 in females only. The marsupium consists of two pairs of foliaceous plates called oostegites (Caprellidae, Laubitz 1976) that grow from gill bases (Fig. 2) (Arimoto et al. 1976; Watling and Carlton 2007).

#### **Coxae:**

**Gnathopod 1:** Male gnathopod one is small and the propodus and dactyl have serrate grasping margins (Fig. 1) while the female gnathopod is small, setose (Fig. 2).

**Gnathopod 2:** Male gnathopod two is very large, especially the propodus, width being less than half overall length. The gnathopod is setose, except the dactyl and distal part of propodus (Laubitz 1970). The basis is small, with no lateral spines at the base (Figs. 1, 1b). The propodus is tuberculate anterodistally and palm is with small proximal grasping-spine, large distal poison spine, large triangular projection distal to poison spine and separated by cleft. There are no anterodorsal projections on propodus in this species (Laubitz 1970) (Fig. 1). The dactyl is heavy, slightly curved, with inner margin slightly denticulate and not setose. The gnathopod is attached just posterior to middle of pereonite two (in male) and attached near the middle of pereonite two, but not at its anterior end (in female) (Laubitz 1970) (Fig. 2). The palm of propodus has a proximal grasping spine and an accessory spine, and a minute distal poison spine (Fig. 3). Ventral spines between insertions of second gnathopods are lacking in this species (Fig. 1a). Female gnathopods are much smaller than those of males.

**Pereopods 3 through 7:** Pereopods 5–7 prehensile (for grasping) and increase in size posteriorly (Fig. 1). Propodus on all pereopods rather stout, with a concave inner edge and a proximal tooth with a pair of

grasping spines (Fig. 1c). Female pereopods more slender than those of males (Laubitz 1970) (Fig. 2).

**Pleon:** The pleon or seventh pereonite is reduced and often unsegmented in caprellids (McCain 1975). Female individuals with one pair of lobes, but no single-articled appendages above these lobes (Figs. 2, 4) (*Caprella*, McCain 1975).

#### **Pleonites:**

#### **Urosomites:**

#### **Epimera:**

#### **Telson:**

**Sexual Dimorphism:** Males much larger and more elongate than females, with a longer first pereonite and an exaggerated second gnathopod. Females when brooding have conspicuous oostegites (see **pereon**) and lack mandible palps (Watling and Carlton 2007).

#### **Possible Misidentifications**

In contrast to the more familiar Gammaroidea, the bodies of caprellid amphipods are elongate and cylindrical, their pereonites are very long and their three pairs of pereopods are prehensile. Caprellids have 2–3 pairs of gills on the middle pereonites and lack the abdominal pleopods of gammarid amphipods. Members of three subfamilies (family Caprellidae) occur locally including, Caprellinae, Paracercopinae and Phtisicinae. The caprellid family Cyamidae are parasitic on cetacean mammals. They are very short bodied, dorso-ventrally flattened (like isopods), and have third and fourth pereonites especially adapted for hanging on to their host.

Phtisicinae have three pairs of gills, not two (unlike Caprellinae). In addition, they have no molar surface on the mandible. The Phtisicinae have rudimentary pereopods on pereonites three and four (Laubitz 1970). Of this family, *Perotripus brevis* has been reported from California (McCain 1975; Watling and Carlton 2007). It, as well as *Cercops compactus* (Laubitz, 1970), occurs in Puget Sound. *Caprella compactus* has also been reported from the outer coast of Oregon, at Cape Arago (Laubitz 1970; Martin 1977) and is in the only representative of the

subfamily Paracercopinae locally. *Cercops compactus* does not have an elongate body as other caprellids do, its abdomen has five segments, and pereonites five and six are short and stout (Watling and Carlton 2007).

The subfamily Caprellinae is the most speciose with 23 species in the genus *Caprella*, three in *Tritella* and one each in *Deutella* and *Mayerella* (Watling and Carlton 2007).

*Tritella* pereopods have only one article and their second antennae have swimming setae (Laubitz 1970; McCain 1975). Three species are found in Oregon: *T. laevis* is strongly stenohaline, and is found offshore from British Columbia, Canada to Monterey Bay, California (Martin 1977). It has anteriorly pointed body spines and short spines on the stout flagellum of its second antennae. This species can display "intersex" features (Laubitz 1970), making males and females difficult to distinguish. *Tritella pilimana* has laterally pointed body spines and its second antennal setae are long on a slender flagellum. It is more euryhaline than *T. laevis* and is found from Alaska to California (Martin 1977). *Tritella tenuissima* is a deep water species, known off shore in southern California. It lacks swimming setae on antenna two and (some believe) should be transferred to the genus *Triliropus* (McCain 1975).

The genus *Metacaprella* was characterized by a pair of appendages above the usual lobes on the female abdomen (McCain 1975) where *Caprella* spp. have only the one pair of lobes (Fig. 4). *Caprella anomala* and *C. kenneryli* were formally members of this genus (*M. anomala* and *M. kenneryli*). Both have a small pair of sharp spines on the heads and are reported from California and from Puget Sound, Washington (Keith 1971; McCain 1975; Martin 1977).

The genus *Caprella* is characterized by the presence of gills on pereonites 3–4, oostegites and mandibles without palps (females) (Watling and Carlton 2007). *Caprella greenleyi* has been reported living on hydroids and algae and on the sea star *Henricia* spp. both in Oregon and in California (McCain 1969, 1975; Martin 1977). Unlike most free-living caprellids, it is quite stout, and has unusual antennae-- both pairs

have only a uni-articulate flagellum (McCain 1975).

A few caprellids have a ventral spine between the insertions of the second gnathopods (*C. drepanochir* does not): *C. californica*, *C. equilibra*, *C. mendax*, and *C. pilidigitata* (Laubitz 1970). *Caprella californica* has a long, forward directed cephalic spine (Laubitz 1970). Both the propodus and basis of the male gnathopod two are very long in this species. *Caprella californica* has a wide distribution from the western to eastern Pacific coasts (Martin 1977). *Caprella equilibra* has no cephalic spine (McCain 1975) (like *C. drepanochir*). But unlike the latter species, it has anterior lateral projections on pereonite five, large lateral spines at the base of the gnathopod two (McCain 1975) (Fig. 1b), and the ventral spines between the gnathopods (Figs. 1, 1a). Northeast Pacific range of *C. equilibra* includes San Juan Islands, Washington and British Columbia, Canada (Martin 1977). *Caprella mendax* has no cephalic spine, no lateral projections on pereonite five, and only small lateral spines at the bases of the second gnathopods. Its dactyl is not setose and its distribution ranges from Vancouver Island, Canada to San Diego, California (Martin 1977). *Caprella pilidigitata* has no lateral spine near the base of gnathopod two and its dactyl is setose.

One group of *Caprella* species has at least a slight cephalic spine (and lacks ventral spines between the second gnathopods, (as above) and includes *C. natalensis*, *C. penantis*, *C. brevisrostris*, *C. pustulata*, *C. simia* and *C. scaura*. *Caprella natalensis* (= *C. angusta* and *C. uniforma*, Watling and Carlton 2007) has a slight cephalic spine and small dorsal pereonite spines, except on pereonite one. Gnathopod two is attached at the anterior end of the second pereonite in males. The northeast Pacific distribution of *C. natalensis* includes British Columbia, Canada to Santa Cruz, California (Martin 1977). *Caprella penantis* is morphologically similar to *C. natalensis* however pereonite five is usually longer than six and seven in the latter species (see Laubitz 1972; Watling and Carlton 2007). *Caprella brevisrostris* has only a very slightly produced rostrum, not a cephalic spine (Arimoto et al. 1976). It differs

chiefly from *C. drepanochir* in that it lacks grasping spines on its pereopodal propodi (Fig. 1c). It has been reported from the coasts of Japan (Arimoto et al. 1976), Korea and China (Martin 1977), and from California (McCain 1975), but not from Puget Sound (Keith 1971) or from Oregon (Laubitz 1970). *Caprella pustulata* (Laubitz 1970) has a dorsal, upward directed knob on its head. The head and pereon are covered with large and small tubercles (Keith 1971). The male is setose on the second gnathopods and on much of the body. The antennae have some very long setae. *Caprella pustulata* is reported from British Columbia, Puget Sound and from Oregon (Laubitz 1970), but not from California (McCain 1975; Martin 1977). *Caprella scaura* (Templeton, 1836), a cosmopolitan species newly found in North America (Marelli 1981), is very like *C. californica* above, except that it lacks a ventral spine between the gnathopods, and has two pairs of dorsal tubercles on pereonites five (Marelli 1981). Pereonite four in adult males is smooth dorsally in *Caprella simia*, a species introduced to southern California from Japan (Watling and Carlton 2007).

Obvious dorsal tuberculations on the pereonites (lacking in *C. drepanochir*) characterize the group composed of *C. alaskana*, *C. ferrea*, *C. incisa*, *C. mutica*, *C. pilipalma* and *C. verrucosa*. *Caprella alaskana* has quite variable dorsal pereonite spines. It has long first antennae, but the flagellum is shorter than the peduncle, not longer. The male second antenna is shorter than the first two articles of the first antenna. Like *C. drepanochir*, *C. alaskana* has a first pereonite not more than twice the length of its head (Keith 1971). It is an intertidal species, found in Alaska and British Columbia, Canada (Martin 1977). *Caprella ferrea* has a pair of small blunt spines on its head (Laubitz 1970). The dorsal pereonite tubercles become large spines in the posterior pereonites (Keith 1971). The first pereonite in the male is about as long as the head (Keith 1971). *C. ferrea* can be similar to *C. alaskana* above in its juvenile and immature stages, but not as an adult (Laubitz 1970). Found in Alaska, British Columbia and in Puget Sound (Keith 1971; Martin 1977). *Caprella incisa* has small dorsal tubercles on its pereonites, the

propodus (on second gnathopod in males) is as long as pereonite two (Keith 1971). Its first antennal peduncle is finely setose (McCain 1975). It has a triangular cephalic projection, directed anteriorly (McCain 1975), which is lacking in *C. drepanochir*. *C. incisa* has been reported from British Columbia, Canada to southern California (Martin 1977). *Caprella mutica*, an Asian species, has now been reported from California (Martin 1977; Marelli 1981), and was found in Coos Bay with *C. drepanochir* (authors). It has also been called *C. acanthogaster humboldtiensis* (Martin 1977). *Caprella mutica* has dorsal projections on pereonites 3–5, but not on the anterior pereonites, which are setose. It has no cephalic projections. The entire second gnathopod (males) is setose in this species (including the dactyl). The pereopodal grasping spines (on propodus) are medial, not proximal as in *C. drepanochir*. *Caprella pilipalma* has low tubercles dorsally, especially on its posterior segments. It has a small, erect, pointed, dorsally directed cephalic spine (Dougherty and Steinberg 1953) and its second gnathopods are attached posteriorly to the second pereonites in the male, and anteriorly in the female (contrast *C. drepanochir*). The large propodus on the male gnathopod two has no poison spine or grasping spine, but does have many long colorless hairs (Dougherty and Steinberg 1953). *Caprella verrucosa* has large, blunt tubercles on all pereonites, it is the most tuberculate of this group. Unlike many of the genus, *C. verrucosa* and *C. drepanochir* have an antennal peduncle which is scarcely setose (Dougherty and Steinberg 1953). The propodus on the second gnathopod in *C. verrucosa* is shorter than the second pereonite (Keith 1971). This species has an anteriorly directed triangular cephalic projection (Keith 1971). Found in Puget Sound (Keith 1971), California, British Columbia, Japan (Martin 1977). Some specimens of *C. verrucosa* from protected waters have a ventral spine between the second gnathopods, in contradiction to most keys (Marelli 1981).

There are two other *Caprella* species, which, like *C. drepanochir*, have no cephalic spines, no ventral spines between the gnathopods, and no dorsal pereonite

projections: *C. gracilior*, and *C. laeviuscula*. *Caprella gracilior* is occasionally found intertidally, but usually inhabits deep water (below 9 m, Laubitz 1970). It has a smooth body, except for two tubercles on pereonite five. The grasping spines on the slender pereopod propodus are medial (not proximal as in *C. drepanochir*). The basis of the male gnathopod two is much longer than the propodus and the dactyl is setose (Laubitz 1970). It has been reported from Alaska, Washington, and California, but not from Oregon (Laubitz 1970). *Caprella laeviuscula* is the most common northeastern Pacific species (Laubitz 1970), and would be expected to be found intertidally in Oregon's estuaries. It is the species most similar to *C. drepanochir* in (according to McCain 1975, which does not include *C. drepanochir*). The main difference is in the gills: they are long and oval in *C. laeviuscula* and round in *C. drepanochir*. The male second gnathopod in *C. laeviuscula* has an extremely large poison spine (it is larger in *C. drepanochir*). The female gnathopod two in *C. laeviuscula* is attached near the middle of the pereonite (Laubitz 1970) (contrast Fig. 2). *Caprella laeviuscula* has a wide northern Pacific distribution from Japan, to Alaska, British Columbia and south to Monterey, California (Martin 1977).

*Caprella carina*, a boreal species, apparently washed ashore in Coos Bay but its local establishment is unknown (Jessen 1969; Watling and Carlton 2007).

### Ecological Information

**Range:** Original description (and presumed type region) from coast of China (Laubitz 1970; Mayer 1890; Guerra-Garcia and Takeuchi 2003). An amphi-Pacific species with a range extending from (Laubitz 1970) Japan, Russia, the Arctic and Alaska as far as Prince William Sound. *Caprella drepanochir* is an introduced species to the northeast Pacific coast and was introduced in ship fouling from Asia (e.g. Japan) to San Francisco Bay, California (Carr et al. 2011) and Oregon (Watling and Carlton 2007).

**Local Distribution:** Coos Bay sites, including dock-side at the Charleston small boat basin.

**Habitat:** Substrate determined by food source as caprellids can cling to almost any surface. They can be found on algae, sponges, etc., but do not like sandy or muddy bottoms (McCain 1975).

**Salinity:** Collected at salinities of 30 (in Coos Bay).

**Temperature:** Primarily an Arctic species in protected, cold-temperature zones (e.g. Prince William Sound, AK) (Laubitz 1970).

**Tidal Level:** Intertidal (Laubitz 1970) and subtidal.

**Associates:** These specimens were collected with *Obelia* sp. from floating docks, but can also occur with the congener *Caprella mutica*. In Japan, they are commonly associated with *Tubularia* sp.

**Abundance:** Locally common in Coos Bay (Charleston boat basin), especially in July. One of the most abundant epifaunal species in eelgrass (*Zostera marina*) communities in San Francisco Bay, California (Carr et al. 2011) and Willapa Bay, Washington (Ferraro and Cole 2007).

### Life-History Information

**Reproduction:** Development in most amphipods is direct, lacking a larval stage. Little is known about the reproduction and development in *C. drepanochir*. Eggs carried by female in marsupium (Fig. 2), until they hatch at 0.4–0.5 mm.

**Larva:** No larval stage is observed *per se*, instead small adult-like juveniles hatch from female marsupium and grow to 1 mm long. Some stay in marsupium until mother's first molt (Japan, Kawana, in Arimoto et al. 1976; Wolff 2014).

**Juvenile:** Some *Caprella* juveniles cling to their mother's body and grow through four molts over a period of 16 days. These juveniles are protected and groomed by their mother (e.g. *Caprella monoceros*, Aoki and Kikuchi 1991) and this extended parental care has been observed in a number of caprellids (Thiel 1997). In other species juveniles do not cling to their mother's body, but remain near her, attached to algae, where they receive protection from predators and other caprellids (e.g. *Caprella decipiens*, Aoki and Kikuchi 1991).

### Longevity:

**Growth Rate:** Amphipod growth occurs in conjunction with molting where the

exoskeleton is shed and replaced. Post-molt individuals will have soft shells as the cuticle gradually hardens (Ruppert et al. 2004). Caprellids undergo repeated moltings as they grow and individuals of a single species can show great variability in size depending upon their age (Arimoto et al. 1976). Sexually mature females are 7.5 mm in length, while males are 18 mm (Arimoto et al. 1976).

**Food:** Caprellids can eat many things by different methods. Presence of plumose setae on second antennae provides the ability to filter food and to scrape periphyton from surfaces to which they cling (Caine 1977) (e.g. *Obelia*, in Coos Bay). Some individuals will nip off hydroid polyps as well as diatoms or detritus (Kozloff 1993). When feeding, the caprellid hangs on with prehensile pereopods and uses antennae and gnathopods for eating.

**Predators:** Caprellids are fed upon by bottom fishes (cod, blennies, skates, sea bass), also by shrimp, anemones (McCain 1975), and hydroids (e.g. *Candelabrum fritchmanii*, Hewitt and Goddard 2001).

**Behavior:** Movement is inchworm-like: grasping substrate with large anterior gnathopods, then pulling up posterior and grabbing on with pereopods and posterior appendages.

## Bibliography

1. AOKI, M., and T. KIKUCHI. 1991. Two types of maternal care for juveniles observed in *Caprella monoceros* (Mayer, 1890) and *Caprella decipiens* (Mayer, 1890) (Amphipoda, Caprellidae). *Hydrobiologia*. 223:229-237.
2. ARIMOTO, I., D. KYOTO, and J. SETO RINKAI. 1976. Taxonomic studies of Caprellids (Crustacea, Amphipoda, Caprellidae) found in the Japanese and adjacent waters. *Nihon Warekararui Shuppanbu*, Yokohama.
3. CAINE, E. A. 1977. Feeding mechanisms and possible resource partitioning of the Caprellidae (Crustacea: Amphipoda) from Puget Sound, USA. *Marine Biology*. 42:331-336.
4. CARR, L. A., K. E. BOYER, and A. J. BROOKS. 2011. Spatial patterns of epifaunal communities in San Francisco Bay eelgrass (*Zostera marina*) beds. *Marine Ecology*. 32:88-103.
5. DOUGHERTY, E. C., and J. E. STEINBERG. 1953. Notes on the skeleton shrimps (Crustacea: Caprellidae) of California. *Proceedings of the Biological Society of Washington*. 66:39-49.
6. FERRARO, S. P., and F. A. COLE. 2007. Benthic macrofauna habitat associations in Willapa Bay, Washington, USA. *Estuarine Coastal and Shelf Science*. 71:491-507.
7. GUERRA-GARCIA, J. M., and I. TAKEUCHI. 2003. The Caprellidea (Malacostraca, Amphipoda) from Mirs Bay, Hong Kong, with the description of a new genus and two new species. *Journal of Crustacean Biology*. 23:154-168.
8. HEWITT, C. L., and J. H. R. GODDARD. 2001. A New species of large and highly contractile hydroid in the genus *Candelabrum* (Hydrozoa : Anthoathecatae) from southern Oregon, USA. *Canadian Journal of Zoology*. 79:2280-2288.
9. JESSEN, M. P. 1969. The ecology and taxonomy of the Caprellidae (order: Amphipoda; Suborder: Caprellidea) of the Coos Bay, Oregon, area. Ph.D. University of Minnesota.
10. KEITH, D. E. 1971. Substrates election in caprellid amphipods of Southern California, with emphasis on *Caprella californica* Stimpson and *Caprella equilibra* Say (Amphipoda). *Pacific Science*. 25:387-394.
11. KOZLOFF, E. N. 1993. Seashore life of the northern Pacific coast: an illustrated guide to northern California, Oregon, Washington, and British Columbia. University of Washington Press, Seattle, WA.
12. LAUBITZ, D. R. 1970. Studies on the Caprellidae, (Crustacean, Amphipoda) of the American North Pacific. National Museum of Natural Sciences (Ottawa)

- Publications in Biological Oceanography:1-89.
13. —. 1972. The Caprellidae (Crustacea, Amphipoda) of Atlantic and Arctic Canada. National Museum of Natural Sciences (Ottawa) Publications in Biological Oceanography: 1-82.
  14. —. 1976. On the taxonomic status of the family Caprogammaridae (Kudrjaschov&Vassilenko) (Amphipoda). Crustaceana. 31:145-149.
  15. —. 1993. Caprellidea (Crustacea, Amphipoda): towards a new synthesis. Journal of Natural History. 27:965-976.
  16. MARELLI, D. C. 1981. New records for Caprellidae in California, USA and notes on a morphological variant of *Caprella verrucosa*. Proceedings of the Biological Society of Washington. 94:654-662.
  17. MARTIN, D. M. 1977. A survey of the family Caprellidae (Crustacea, Amphipoda) from selected sites along the northern California coast. Bulletin Southern California Academy of Sciences. 76:146-167.
  18. MAYER, P. 1890. Nachtrag zu den Caprelliden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte : Mit 7 Tafeln in Lithographie. R. Friedländer u. Sohn, Berlin.
  19. MCCAIN, J. C. 1969. A new species of a caprellid (Crustacea, Amphipoda) from Oregon. Proceedings of the Biological Society of Washington. 82:507-509.
  20. —. 1975. Phylum Arthropoda: Crustacea, Amphipoda: Caprellidea, p. 367-376. *In*: Light's manual: intertidal invertebrates of the central California coast. R. I. Smith and J. T. Carlton (eds.). University of California Press, Berkeley California.
  21. MYERS, A. A., and J. K. LOWRY. 2003. A Phylogeny and a new classification of the Corophiidea (Leach, 1814) (Amphipoda). Journal of Crustacean Biology. 23:443-485.
  22. RUPPERT, E.E., R.S. FOX, and R.D BARNES. 2004. Invertebrate zoology: a functional evolutionary approach, 7<sup>th</sup> Edition. Thomson Brooks/Cole, Belmont, CA.
  23. TAKEUCHI, I. 1993. Is the Caprellidea a monophyletic group. Journal of Natural History. 27:947-964.
  24. THIEL, M. 1997. Another caprellid amphipod with extended parental care: *Aeginina longicornis*. Journal of Crustacean Biology. 17:275-278.
  25. UTINOMI, H. 1943. The fauna of Akkeshi Bay XIII. Caprellidae. Journal of the Faculty of Science, Hokkaido Imperial University. 8:283-300.
  26. WATLING, L., and J. T. CARLTON. 2007. Caprellidae, p. 618-629. *In*: The Light and Smith manual: intertidal invertebrates from central California to Oregon. J. T. Carlton (ed.). University of California Press, Berkeley.
  27. WOLFF, C. 2014. Amphipoda, p. 206-209. *In*: Atlas of crustacean larvae. J.W. Martin, J. Olesen, and J. T. Høeg (eds.). Johns Hopkins University Press, Baltimore.